Removal of Pea Crabs from Live Oysters by Using Sevin®

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Minchinia nelsoni, a haplosporidian parasite, known by the anonym MSX, caused a severe epizootic of oysters in Chesapeake Bay beginning in 1959 (Andrews, 1967). Old surviving oysters were dredged for breeding in 1964 but occurrence of pea crabs (*Pinnotheres ostreum*) was high. Poor condition, attributed in part to the parasitic crabs, made spawning and stripping of sexual products difficult. In the fall of 1964, progeny of these survivors being monitored for resistance to MSX also acquired serious infestations of pea crabs. Although early growth appeared normal, lots held at VIMS pier contained stunted oysters at 2 years of age in 1966. These stunted oysters often contained large pea crabs. A safe method of removing pea crabs from live oysters was needed to eliminate another variable in our field tests of oysters for disease resistance.

In 1966, Miss Hreha, a NSF summer research student, was assigned the task of finding a method for removal of pea crabs. After brief attempts with low-salinity waters, we turned to Sevin, a widely used pesticide for insects and crustaceans. Our objective was short-term exposure to kill the crabs rather than continuous exposure at low concentrations commonly used in tolerance studies. A method was developed which removes pea crabs without harming oysters.

The choice of Sevin was based on garden experience and literature which indicated low toxicity for mammals and quick detoxification. Also, we found later that Loosanoff (1961, 1965) had casually reported control of *Pinnotheres ostreum* on oyster beds treated with Sevin and chlorinated benzenes. Probably Sevin was the effective agent and he suggested use of this insecticide for pea crabs in 1961.

MATERIALS AND METHODS

For treatment, oysters were crowded in shallow pans (25 in a pan 18 by 24 by 4 inches) holding about 10 l of water. Technical Sevin (95%) in powder form was added to freshly pumped ambient sea water by stirring. Very low solubility of Sevin made concentrations to which oysters were exposed quite subjective. Periods of exposure and concentration of pesticide were gradually reduced as elimination of crabs continued successfully. Periods of time for expulsion were measured from the beginning of treatment. After exposure, oysters were held in standing or running water until sacrificed or returned to the York River. Wooden vats were used for treating trays of experimental oysters.

RESULTS

Summer Studies: Oysters 2 years or more of age were treated. Only mature pea crabs were present. Treatments were for 24 hours with 100 mg/l of Sevin followed by continued observation in trays of running sea water. Concern that oysters might not pump led to use of freshly-drawn salt water and addition of cultured algae.

Five lots of old oysters from one tray of dredged survivors of MSX were treated. Some crabs became apparent in 4 hours after Sevin was first added and most were out or protruding from oysters within 48 hours (Table 1). All samples had over 50% prevalence of crabs. Oysters extruding crabs were marked for later observations of gill and palp damage. Damage by mature crabs to gill lamellae was always quite evident (see Stauber,

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1945). No additional crabs were found when oysters were opened after 72 hours. All crabs were dead.

Table 1

Expulsion[1] of Pea Crabs by Old Mobjack Bay Oysters exposed 24 hours to 100 mg/l of Sevin (2 to 12 August 1966)

No. of oysters	Number of pea crabs expelled in 24 hrs.	48 hrs.	72 hrs.	Total
25	9	2	3	14
25	9	5	1	15
25	12	1	1	14
27	12	7	1	20
27	10	3	2	15
Total: 129[2]	52	18	8	78

[1] Defined as first appearance of pea crab along valve margins.
[2] Pea crabs in 60% of oysters

Mature crabs were slowly extruded (often visible several hours on shell margins) after compression by valve action or decay. Most crabs were pushed out the ventral margin opposite their position posterior to the palps in the oysters. Legs usually appeared first but sometimes the orange-red egg sponges were the earliest parts visible.

Smaller oysters (2-year-olds) yielded 26 crabs from 97 oysters, of which 4 came out on the fourth and fifth days. The crabs ranged from 4 to 15 mm but only 2 were less than 9 mm. These oysters were not sacrificed because they were progeny being monitored for resistance to MSX. The treated oysters, returned to trays in the York River, exhibited no differences from controls in growth and mortality during the subsequent year. Other groups gave similar results, with all crabs dead or dying even when found inside oysters.

Winter Experiments: The winter experiments focused on small crabs in dormant oysters whereas the summer studies involved large crabs and active oysters. In the winter of 1966/1967, attention was given to removal of immature crabs after a rather heavy late-summer infestation of oysters at VIMS pier. Our objectives were to determine the effects of temperature, dosage of Sevin, length of treatment, and method and timing of ejection of small crabs. Crabs of the 1966 year-class (prehard to stage III and 1.6 to 5.2 mm in carapace width) were easily distinguished from older mature ones (stage V and 8 to 15 mm). Descriptions of small crab stages are given by Stauber (1945) and Christensen & McDermott (1958).

We were concerned about effects of dosage and length of exposure time on oysters in winter because running water could not be used effectively. Oysters were inactive at ambient winter temperatures of about 5°C and warming to induce pumping was presumed to be necessary.

In a series of experiments, dosage was reduced from 100 mg/l to 50, 25, and 10 without change in effectiveness and timing of expulsion. Furthermore, treatment with Sevin was reduced from 48 hours (crabs were ejected more slowly in winter) to 12 hours with complete elimination of crabs thereafter. At first pan water was warmed to room temperature and cultured food added before treating oysters. However, oysters placed in ambient river water with Sevin added and allowed to warm for 12 hours at room temperature pumped sufficiently to kill and expel small crabs within 48 hours (water changed to remove Sevin at 12 hours). Small crabs (< 5 mm) were ejected intact (sometimes moribund) beginning about 12 hours after initial treatment and usually removal was completed in 48 hours. Large crabs (> 8 mm) took several days to be extruded, depending upon size of oysters and rate of decay of pea crabs.

In all experiments, oysters were held 48 hours or longer and pea crabs were collected frequently. It was not always possible to determine which oysters ejected small pea crabs. All oysters were opened and examined for pea crabs and gill injury. Almost without exception and regardless of size of crabs, conspicuous and characteristic gill damage was observed. Data on sexes, stages and sizes of pea crabs were collected.

Table 2

Prevalence of Pea Crabs in VIMS Pier Oysters

Date	No. of oysters	No. of pea crabs	% prevalence
Jan. 13 - 16, 1967	33	9	27.3
Jan. 26 - 31	30	22	73.3
Feb. 1 - 6	60	35	58.3
Feb. 9 - 12	40	21	52.2
Feb. 18 - 20	25	12	48.0
Feb. 21 - 24	50	33	66.0
Feb. 28 - Mar. 2	40	16	40.0
May 31 - June 7	30	7	23.3
June 26	25	5	20.0
Total	278	146	52.5

Prevalences in 1964 year-class oysters attached to pilings at VIMS pier are given for the winter of 1967 (Table 2). Oysters were treated with various dosages of Sevin for 12 to 48 hours and were opened from 2 to

several days after first treatment. The small crabs were nearly always out in 48 hours but large crabs were found dead or dying in opened oysters. All crabs were expelled if oysters were held a week or more, even at ambient (winter) water temperatures. Only 11 of 146 pea crabs in Table 2 were stage V crabs (6 to 12 mm). The rest were 1966 year-class pea crabs (prehard to stage III). The decrease in prevalence between winter and June samples is probably due in part to disappearance of males which were last found in the May 31 lot (see Christensen & McDermott, 1958). Possibly tiny crabs were overlooked in the first sample, thereby accounting for the low prevalence, or oysters from a higher level on pilings may have been used.

RECOMMENDED TREATMENT

Our purpose was to find a program of treatment which would remove pea crabs from oysters without injury to the hosts. We sought a simple and quick method for experimental purposes only. Oysters pumped freely in Sevin concentrations up to 100 mg/l. Use of Sevin in a fine hydrophobic powder state raised questions about the concentration in solution. Lowe (1967) states that the reported solubility of Sevin in water is less than 99 mg/l. Hence, all of our experiments were conducted within the probable solubility range of Sevin although not all flakes were dissolved, particularly at 100 mg/l despite limited stirring.

In October 1967 and April 1968, experiments were performed using Sevin powder and Sevin dissolved in 50 ml of acetone at 1 and 10 mg/l. Only mature pea crabs of the 1966 year-class were available in oysters because infestation by pea crabs failed completely in 1967 in lower Chesapeake Bay. Acetone appears to hasten the appearance of pea crabs being extruded between the valves of oysters but both treatments were equally effective in eventual removal of the parasites. For example, Brown Shoal oysters with a prevalence of 13 pea crabs in 25 oysters, were treated with 10 mg/l of powdered Sevin on Tuesday. By Friday 1 pea crab was out and another visible. Then the oysters were placed in the York River to stimulate pumping and were opened Monday. Seventeen of 26 oysters showed typical gill erosion and only 1 decaying pea crab was found. Mature pea crabs cannot physically pass between the valves of oysters until they are mashed or rotted into a collapsed state.

For simplicity we recommend treatment for 24 hours with 10 mg/l of powdered Sevin in ambient sea water. Oysters should then be placed in natural waters where vigorous pumping will occur and pea crabs be expelled.

DISCUSSION

Pea crabs are killed when the oyster hosts are exposed to 10 mg/l technical Sevin in freshly drawn sea water for 24 hours. After this exposure, oysters may be returned to ambient conditions with a high probability that pea crabs will be eliminated. Salinity and temperature levels are not crucial provided the oysters pump. In winter, standing sea water should be allowed to warm from ambient temperatures during treatment. Attempts to accelerate pumping with artificial food were ineffective and unnecessary.

Sevin is toxic to pea crabs at concentrations of less than 10 mg/l as it is to other arthropods and fish (Lowe, 1967). Pea crabs in oysters were killed with 1 mg/l Sevin in acetone in one experiment. Heavier dosage seems to provide quicker response in terms of appearance of large pea crabs being ejected from oysters. For our purpose, a dosage of 10 mg/l for limited periods seems reasonable in view of rapid hydrolysis of Sevin. Although 12 hours has been adequate for killing crabs in oysters, 24 hours provides some margin for oysters which may be slow to resume pumping, and longer exposure does no harm. No attempt has been made to determine critical toxicity levels for oysters or crabs because chronic exposure is not desirable or necessary. No consideration was given to testing oysters for Sevin or its derivatives since the method is intended only for experimental purposes.

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